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RECOVERY OF SPENT LIME AT THE COLUMBUS WATER SOFTENING AND PURIFICATION WORKS

By Charles P. Hoover

At the Columbus water softening and purification works, lime and soda ash are used to soften the entire water supply of the city, which will average about 20,000,000 gallons per day. Approximately 76 per cent of the lime which is added to the local water absorbs carbon dioxide and is thus converted to calcium carbonate, and the soda ash combining with the sulphate of calcium also forms calcium carbonate, which is practically an insoluble and precipitable compound.[1] The average quantity of lime added to the water, for absorbing carbon dioxide is 7.3 grains per gallon, and the average quantity of soda ash is 7.3 grains per gallon. Every grain of lime which is added to the water precipitates 3.57 grains of calcium carbonate, and every grain of soda ash added to the water produces 0.93 grains of calcium carbonate.

During the year 1914, 3540 tons of lime were used for absorbing carbon dioxide, and 3540 tons of soda ash were used. The addition of these chemicals resulted in the precipitation of 15,930 tons of calcium carbonate, which if dried, burned and reclaimed would produce theoretically 8,921 tons of lime.

It has always been the practice at this plant to settle this calcium carbonate in concrete settling basins, and to periodically wash these settlings into the river below the pumping station intake. The Scioto River is a small stream, and during the summer months, when the flow of water is sluggish, there is not sufficient velocity to carry this material down stream, consequently the bed of the river becomes choked with these settlings and has resulted in some trouble between the city of Columbus and riparian property owners below.

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[1] The remaining 24 per cent of lime precipitates magnesium.

During the summer and fall months, the water of the Scioto River is usually clear, and it is in this season of the year that the water shows its maximum hardness, and, therefore, at this season the maximum quantity of calcium carbonate sludge is produced. During the winter and spring months, when the water from the river is usually very muddy and soft and the quantity of lime sludge is small, the flow of the water in the river is rapid, so that there is no objection to turning this sludge into the river during these periods of the year. The calcium carbonate which is precipitated from the water during the season of the year when the water is clear and hard shows the following analysis.

	per cent
Water	82.0
Gravity	1.126
Silica	4.72
Iron and alumina	2.2
Calcium (as calcium oxide)	45.24
Magnesium (as MgO)	4.27

Theoretically it is possible to produce from this sludge a lime containing 79.48 per cent calcium oxide.

During the winter and fall months, when the river water is muddy, the sludge is so contaminated with mud that there seems to be no economical method for reclamation, but, as has already been explained, this muddy precipitate is only obtained when the river is high, and at such times there is no objection to flushing it into the river.

A plan of recovery for spent lime is contemplated, which will be about as follows:

The settling basin precipitate will be pumped into a thickener, and from the thickener the material will be fed directly into a rotary kiln, where it will be burned into lime. This plan may be changed somewhat in the final design, and the material, after passing through the thickener, may be filtered by means of a suction filter of the continuous type, and then fed into the kiln and burned. Elaborate experiments have been carried on during the past few months, and a picture of the experimental plant, which was used in these experi-

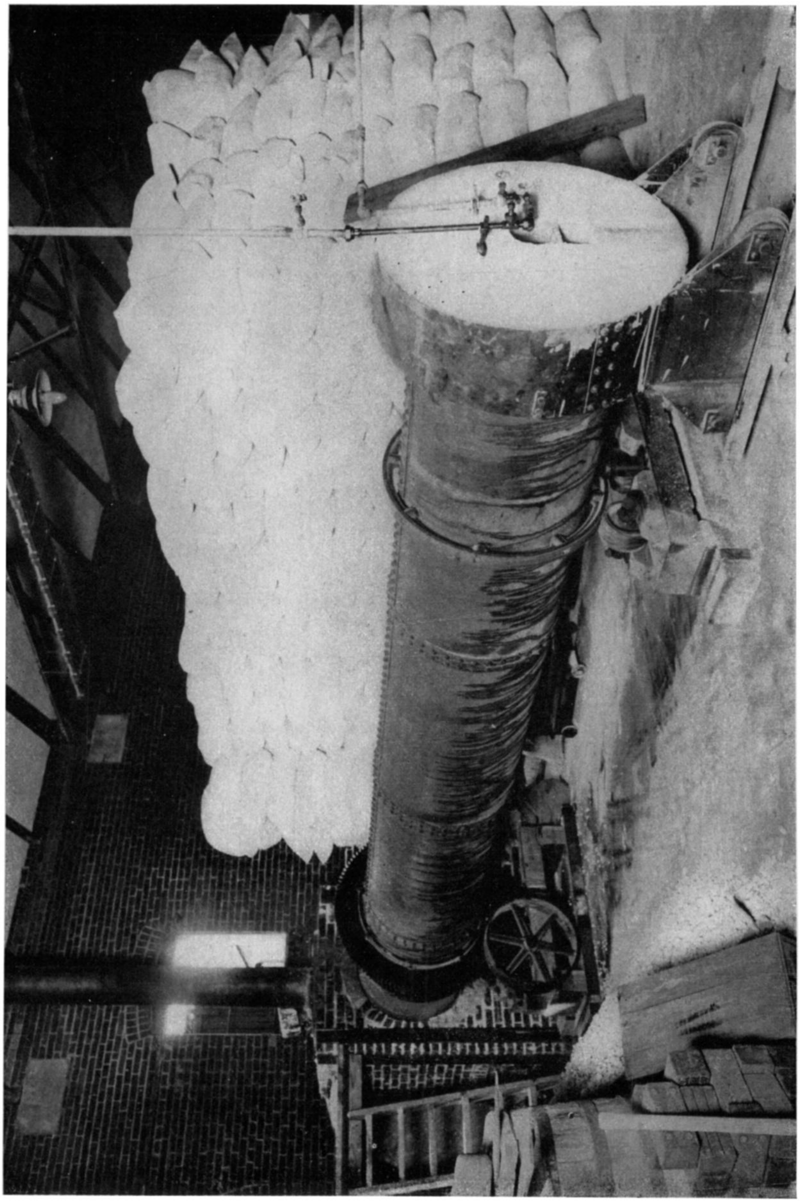

FIG. 1. EXPERIMENTAL KILN FOR RECLAIMING LIME FROM SLUDGE

ments, is shown in figure 1. The kiln is 20 feet long and 34 inches in diameter, and was fired with a Rockwell burner, using fuel oil. 5000 pounds of lime was produced from this kiln, and was used as the softening agent for the entire water softening plant for a period of four hours, during which time 4,000,000 gallons of water were treated. During this large scale test, 42 samples of water were collected, 15 of which were taken at different points in the plant for a period of three hours previous to the time reclaimed lime was used, 20 of which were taken during the time the reclaimed lime was being used, and 15 of which were taken after the use of the reclaimed lime had been stopped, and during which time the high calcium lime, which is ordinarily used, was being used.

The results of these tests indicate very clearly that it was possible to obtain just as good results from this reclaimed lime as with the high calcium lime ordinarily used. The reclaimed lime falls from the kiln in single round lumps, the size ranging from 1 inch to dust, and this is a very convenient size to handle in the present automatic lime weighing scales now in service for weighing lime into the lime slackers. The analysis of the reclaimed lime showed that it contained from 63 to 73 per cent of water soluble calcium oxide, whereas, the lime which is ordinarily purchased at the plant for water softening purposes contains 88 per cent calcium oxide. The interesting feature of this process is that during the period when it is practical to reclaim the spent lime it is possible to produce more lime than is required for use in the softening of water.

There are large limestone quarries within two miles of the water purification works, and limestone containing 90 per cent of calcium carbonate can be purchased at a very low price. The recovery plant will, therefore, be built so that either lime sludge or locally obtained crushed limestone may be burned. During the season of the year when the water is muddy, and it is not practical to reclaim the sludge, limestone will be burned. Samples of the local limestone have been burned in the experimental rotary kiln and lime containing 75.62 per cent of water soluble calcium oxide has been produced. It is estimated that a 65 per cent water soluble calcium oxide lime can be produced from the sludge at a cost of $1.75 per ton, which according to our present contract price is worth $3.40 per ton, and 75 per cent lime can be produced from local limestone at a cost of $2.50 per ton, which will have a value of $4.19 per ton.

At the present time the city of Columbus contracts for lime under the following specifications:

> The city shall pay a bonus of 1½ per cent of the contract price per ton for each 1 per cent by which the water soluble calcium oxide in any car load lot delivered shall exceed 88 per cent, and shall deduct a penalty of 1.5 per cent of the contract price per ton for each 1 per cent by which the water soluble calcium oxide in any carload lot shall be less than 88 per cent.

The contract price of lime is $5.17 per ton; and 4650 tons of 88 per cent lime were used last year. It is estimated that 2500 tons will be produced from lime sludge at a saving of $1.65 per ton, and 3000 tons from local limestone, at a saving of $1.69 per ton; therefore, the installation of this lime plant will result in a saving to the city of approximately $9000, and it is estimated that the plant will cost $30,000.

DISCUSSION

Mr. Charles P. Hoover: The author regrets that he has no drawings with him showing the construction of the Filtros wheel. Briefly, however, this filter is a vacuum operated segmented wheel made out of filtros, a very porous mineral medium. The wheel consists of sixteen segments or compartments, and circulates through a trough holding the lime sludge. Fourteen of the compartments are constantly in communication with a vacuum line, eight of these are always submerged in the lime sludge, and six are exposed to the air, the vacuum withdrawing the moisture during the period of exposure. The dried sludge is scraped off of each compartment just before it advances to the point of submergence into the sludge.

Mr. G. M. Gadsby: Does it take the sludge long to settle?

Mr. Charles P. Hoover: The sludge settles very quickly; in 15 minutes all the sludge is settled from the water.

Mr. Paul Hansen: The speaker does not exactly understand the process that you expect to install. Has not the Dorr thickener a sort of false bottom for carrying away the liquid?

Mr. Charles P Hoover: Yes.

Mr. Paul Hansen: Will not the impurities increase in quantity as the sludge is used over and over again?

Mr. Charles P. Hoover: Yes, they certainly will.

Mr. Paul Hansen: Is that not an objection? If that is so, to what extent is that an unfavorable factor?

Mr. Charles P. Hoover: We do not intend to make lime from the sludge continuously, but for a period of six or eight months in each year. During the rest of the year the water to be softened and purified is so muddy and the sludge so dirty it would be necessary to discard it, probably by forcing it back into the river, and during this period of the year lime will be made from limestone, and in this way an entirely new supply of sludge will be obtained.

Mr. Paul Hansen: To what extent will the impurities accumulate within the six months; that is, how large will be the percentage of impurities at the end of that time?

Mr. Charles P. Hoover: The author is unable to give you offhand any exact figures as to that; but that feature will be overcome or provided against by mixing the sludge with crushed limestone. We contemplate using 85 per cent of the lime sludge, mixed with 15 per cent crushed limestone, and in that way keep up the strength of the lime and thus provide against the accumulation of impurities.

Mr. Frank E. Hale: You said you produced twice as much lime product at your plant as would be necessary, so that for six months you would get enough lime for the year; you will have to discard some of that.

Mr. Charles P. Hoover: We expect to dispose of any excess of lime produced, for agricultural or other purposes.

Mr. John H. Gregory: It is a source of great satisfaction to the speaker that Mr. Hoover is now working out some of the original thoughts brought up at the time the Columbus works were built. It was well known at that time that there was a large quantity of limestone in and around Columbus, and the question came up as to whether it would be feasible not only to produce lime from the local stone, but also to produce a sufficiently good lime in large quantities. Another factor that was considered at the time the works were designed was the question of recovering some of the spent lime, and it was believed then that it would probably be practicable to install some process for the recovery of some of this lime. The problem which confronted the city, however, was to design a large filtration and water softening plant which could be put under contract and built at the earliest possible date. While it was felt that it would be possible to recover some of the spent lime, the engineers connected with the work did not think that any time should be spent in experimental work to ascertain how best to recover this lime, and, at the same time, they felt that an installation should not be made until some experimental work had been done.

The question of how best to handle the lime sludge deposited in the settling basin was one to which considerable thought was given, and in a general way two methods were outlined. One was to be able to pump the sludge from the bottom of the settling basin, by means of a centrifugal pump, electrically operated, carry it on a scow to some sludge depository where the sludge could be air dried. To permit this method of operation, openings were left in the dividing walls which separated adjacent settling basins, so that it would be possible to float the scow from one basin to another. These openings extended down a few feet below the surface of the water, but were temporarily bricked up and plastered over, for the sake of appearance. Another scheme was that of first drawing off the softened water above the sludge, through a drain running to the raw water suction well, and from which it could be pumped back to the purification works, and in each settling basin an outlet chamber was built for this purpose, it being so arranged that the water, down to a certain depth, could be drawn off, leaving the sludge on the bottom of the basin; the sludge then to be run out through a drain. Up to the present time the sludge has been run out through this drain to the river, but it would be a simple matter to divert the sludge to a settling pond, if desired.

The situation as to the installation of the thickener in the settling basin, to which Mr. Hoover has replied, is not entirely clear, and the speaker would like to ask if it is proposed to put in a device which is sufficiently large to fill the space between the baffle wall and the dividing wall and which is to operate practically continuously?

Mr. Charles P. Hoover: That is the idea.

Mr. John H. Gregory: That means then that as the sludge, which deposits quickly, comes into the settling basin, it will be drawn out continuously.

Mr. Charles P. Hoover: Yes, continuously.